

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶: H04M 1/02, H04R 1/30	A1	(11) International Publication Number: WO 97/42747 (43) International Publication Date: 13 November 1997 (13.11.97)
(21) International Application Number: PCT/US97/07487 (22) International Filing Date: 2 May 1997 (02.05.97) (30) Priority Data: 08/642,746 3 May 1996 (03.05.96) US (71) Applicant: ERICSSON INC. [US/US]; 7001 Development Drive, P.O. Box 13969, Research Triangle Park, NC 27709 (US). (72) Inventor: RABE, Karl, W.; 847 White Cross Road, Chapel Hill, NC 27516 (US). (74) Agents: MOORE, Stanley, R. et al.; Jenkins & Gilchrist, P.C., Suite 3200, 1445 Ross Avenue, Dallas, TX 75202 (US).		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>
(54) Title: ACOUSTIC HORN FOR USE IN CELLULAR FLIP PHONES		
(57) Abstract <p>A pivotable flip element for use with hand-held radiophone units is specially configured to provide highly efficient coupling of acoustic energy into and out of the radiophone by virtue of an acoustic horn precisely formed as an interior cavity of the planar pivotable element. When arranged as a device for coupling acoustic energy into a microphone fixedly mounted to the radiophone housing, incident sound is directed from the horn mouth to its throat section, and thereafter through a rotary acoustic joint to an input channel to the microphone. The continuously rotatable rotary joint accommodates flip element rotations, allowing for the dual-purpose operations of protecting and covering the radiophone keyboard when not in use, and efficient input sound coupling when deployed.</p> <div data-bbox="1071 1113 1396 1932"> </div>		

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

-1-

ACOUSTIC HORN FOR USE IN
CELLULAR FLIP PHONES

Technical Field

5 The present invention relates generally to the
coupling of acoustic energy into and out of electronic
devices, and more particularly to specially formed and
articulated passive acoustic elements advantageously
coupled to active acoustic transducers to provide
10 improved electroacoustic operation of and mechanical
protection for radiophones embodying the acoustic
elements.

Background

15 Acoustic transducers of all types for use in audio
communication systems have a long history of development.
To a large degree, the race between improvements in
transducer characteristics and the adaptations of elec-
tronic circuitry to optimally interface with any given
transducer has proven to be a virtual marathon. Early
20 microphones and speakers based largely on mechanical
principles gave way to variable resistance/variable
electromagnet types that better lent themselves to
improved amplification and frequency response per-
formance. Often times, the transducer types and charac-
teristics were adapted to exploit newly available capa-
25 bilities of electronic devices - low noise FETs (high
impedance), feedback networks (passband tailoring), and
current mirror amplifiers (low impedance). With the
advent of highly sophisticated cellular radiophone
systems with their dramatically improved signal-to-noise
30 ratios, the acoustic quality of their input and output
audio devices has come under close scrutiny. So have
their costs. The combination of an inexpensive passive
acoustic device intimately coupled to an input microphone
(or output speaker) associated with high quality radio-
35 phone units as taught in the present invention provides

-2-

significantly improved technical and operational performance of its associated radio communication system.

5 Descriptions of typical prior art approaches to acoustic coupling techniques for use with electronic devices may be found in a number of U.S. patents. Regarding the overall concept of combining an acoustic horn as the output device for a portable radio, see U.S. Patent 3,748,583 to Anderson et al. In particular
10 therein, note the use of a folded hyperbolic acoustical horn for directing audio toward a user.

European Patent 0 275 966 to Schön et al. discloses the inclusion of a sound-carrying conduit into a movable flap element used to cover the control pad of a telephone handset. The conduit is tapered to route input speech to
15 a microphone within the handset via an admitting opening that aligns with the microphone input only with the flap opened to its maximum. No structural details of the sound-carrying conduit are given.

U.S. Patent 1,818,654 to Steuart discloses the use
20 of a funnel-like mouthpiece which is coupled to an early (1931) telephone microphone via two rotating joints. The two joints allow both vertical and horizontal adjustability of a circular input opening via several tapered cylindrical tubes.

25 Other U.S. patents of general interest for their showings of acoustic horn structures or radiophone input sound I/O techniques are U.S. 5,384,844 to Rydbeck, 4,171,734 to Peveto et al, and 3,249,873 to Whitemore, Jr., et al.

30 Beyond the patent literature, the published technical literature also provides useful description regarding the desirable attributes of exponential horns for sound propagation. In particular, a 1924 A.I.E.E. article authored by C. R. Hanna et al. is of interest for its
35 teaching of the theoretical considerations pertaining to the design of acoustic horns for best sound propagation.

-3-

Objects of the Invention

It is therefore a primary object of the present invention to provide improved methods and apparatus for coupling acoustic energy into or out of electronic devices.

A further object of the present invention is to provide methods and apparatus for implementing an improved acoustic coupling capability based on a dual-purpose pivotable acoustic element.

A yet further object of the present invention is to provide an acoustic horn formed as an interior cavity within a pivotable flip element configured for use as the input or output acoustic coupling element associated with a radiophone device.

In a preferred embodiment, a flared acoustic horn of the exponential type is formed as an interior cavity within a flat, planar flip element associated with a cellular radiophone unit. The flip element is dual purpose, providing its conventional function of protecting and covering the radiophone user-activated dialing/function keys in a first, closed position - and additionally constituting a highly efficient input acoustic coupling device via an acoustic rotary joint. The two aspects operating together provide a new operating mode combining physical protection and low cost, highly efficient input acoustic coupling to produce an improved radiophone unit.

Brief Description of the Drawings

Additional objects and advantages of the invention will become apparent to those skilled in the art as the description proceeds with reference to the accompanying drawings wherein:

FIG. 1 is a perspective view of a hand-held cellular radiophone unit embodying a flared acoustic horn as its acoustic input coupling element according to the present invention;

-4-

FIG. 2 is a plan view of an illustrative, basic acoustic horn in highly schematic form adapted to be formed into a flip cover of a radiophone unit;

5 FIG. 2A is a fragmentary plan view of an alternate acoustic horn arrangement for use with the present invention;

10 FIG. 3 is a perspective view of a flip cover (partially in phantom) showing additional mechanical and acoustic details of another alternate acoustic horn arrangement; and

FIG. 4 shows an alternate embodiment of an acoustic horn structure by way of an elevational view of the basic horn mouth.

Best Mode for Carrying out the Invention

15 Referring now to FIG. 1 there is shown a perspective view of a hand-held cellular phone unit embodying an acoustic horn as an input acoustic coupling element according to the present invention. The overall phone unit 10 is housed within a casing 12 having apertures 14
20 for radiating sound from an internally mounted speaker (not shown). The casing 12 carries a dual-purpose flip cover 16 pivotably mounted at its lower end and formed to include a flared acoustic horn that serves as an input energy coupling element for a microphone used with a
25 transceiver disposed within the casing 12. The phone unit 10 further includes a display unit 18, a control key section 20 with the user-actuated key surfaces disposed in a key surface plane, and an antenna 22 - all as well known and conventionally constructed. Cellular phone
30 units readily adapted for incorporating the unique features provided by the present invention are described in an Ericsson Inc. (of Research Triangle Park, North Carolina) Product Bulletin CEL4000 © 1995 and CEL4001 © 1995. The flip cover 16 is shown as pivoted to its
35 deployed position via a pair of hinges 16H and 16θ, and as having an input mouth aperture 24. When the phone

-5-

unit is not in active use, the flip cover 16 may be pivoted to its closed position so as to closely cover and protect the control keys 20.

FIG. 2 is a plan view of an illustrative, basic acoustic horn in highly schematic form, specially configured for being formed into the flip cover 16. The sound collecting and channeling acoustic horn itself is formed as a flared cavity 26 within the cover 16, having a mouth or aperture end 24, and a throat end 28. At any point along the curved central axis 30 of the horn, between the mouth 24 and the throat 28, the incident sound pressure is at some intermediate value between its greatest pressure at the throat and its least pressure at the mouth. The actual manner in which the sound pressure varies is dependent on the rate of growth of its cross-sectional area. This cross-sectional growth is determined by the law under which the horn expands. In a preferred embodiment hereof, expansion is contemplated as being of the exponential type. As an exponential device, the horn 26 serves as a remarkably efficient impedance matching means between the source of the incident acoustic energy (or sound) at its mouth and its throat. When the throat 28 is properly routed via a suitable rotating acoustic joint 16 θ to a microphone 32, the phone unit 10 of FIG. 1 is ideally adapted to provide its unique benefits to a cellular phone user.

Operationally, the basic exponential horn 26 may be configured to exhibit high frequency cutoff in the range of 3-5 kHz, and both rising to flat response curves may be obtained. By use of suitably positioned dampening elements, such as thin layers or discrete portions of foam/elastomeric materials (not shown), the actual operating characteristics of the horn 26 may be made to closely approach theoretically expected values.

Other acoustic horn types are contemplated for use in implementing the present invention. These may include

-6-

horns of the conical type, parabolic type, hyperbolic type, plus other shapes and types.

FIG. 2A shows an alternate embodiment of an acoustic horn and its acoustic input arrangement which may be advantageously employed in the present invention. A modified horn 26' is formed as previously described into a flip cover 16', but has the acoustic input to its mouth or aperture end displaced to the top surface of the flip cover 16' in the form of a plurality of suitably sized and shaped openings 24'. Therefore, the length of the horn 26' stops a small distance short of the end of the flip 16', and the input acoustic energy is coupled into the horn via the top openings 24' - in lieu of the edge aperture 24 shown in FIG. 2. A number of small partition-like structures may extend between the upper and lower flip surfaces to provide strengthening of the horn in the vicinity of the openings 24' - all of which provides an enhanced input arrangement for this alternate embodiment. Additional description of the partition-like structures will be described below in connection with the description of FIG. 4.

With brief reference to FIG. 3, additional mechanical and acoustic details of another alternate embodiment of the flip cover and its modified internal acoustic horn are provided. The cover 16* is generally planar in shape and is formed as a thin, flat member with a pair of hinge elements at one end. A pair of axial hinge pins 34 and 36 guide the rotation of the cover 16*, with pin 36 carrying an interior coaxial opening or channel 38 for routing the throat sound pressure to a microphone (not shown) mounted in the body of the phone unit 10. In a particularly preferred embodiment, the flared horn 26* is (as is the flared horn 26' of FIG. 2A) rectangular in cross section and may extend up to 60 mm (about 2.3 inches) in length L from throat to mouth, not including a short transition channel connecting the throat 28 to the channel 38. Its aperture or mouth

-7-

width W may be 40 mm (about 1.6 inches), and its aperture or mouth height H may be 1-2 mm. The physical extent and shape of the horn 26* are substantially the same as those of 26' of FIG. 2A; many of the identifying legends have
5 been omitted to provide an uncluttered illustration. Phantom lines suggest the general outline of the horn 26* as well as a thin, rectangular cover element 29. One or more input openings 24* (two shown, illustratively) serve to couple the incident acoustic energy into the mouth of
10 the horn 26*. The opening(s) 24* are formed into the top surface of the flip 16* so as to extend slightly beyond the edge of the cover 29.

For positive mechanical action, the hinge pivot pin areas may include suitable detenting means operative in
15 combination with mating structures formed into the casing 12. For loss free coupling of acoustic pressure from the horns 26, 26', or 26* to the microphone 32, appropriate sealing means are called for. In the interest of
simplicity of exposition, detenting and sealing means are
20 not shown, their design and construction being well known.

The flip covers 16, 16', or 16* may be made of any of a number of high impact plastic materials. A particularly desirable feature of these plastics is their
25 ability to be precision formed using existing and low cost manufacturing techniques. Thus, the interior cavity forming the outer boundaries of the various horn 26 embodiments may be precisely and highly smoothly formed, thereby achieving highly efficient acoustic coupling
30 structures.

Additional operating efficiency may be obtained in certain operating environments by use of the auxiliary horn structures suggested in FIG. 4. A plurality of thin
35 partitions 42 inserted into the horn mouth 24 and extending for a significant fraction of the horn length divides the horn's input region into a number of smaller elementary sections. The length of these illustrative

-8-

partitions is shown by the extent of the dotted lines 30P of FIG. 2. The partitions 42 function both to shape the directivity of the horns 26 by lessening their sensitivity to acoustic energy arriving at highly oblique angles, as well as to provide physical strengthening to flip covers 16. When employed primarily for strengthening, as in the embodiment of FIG. 3, their physical length may be somewhat lessened.

Although the invention has been described in terms of selected preferred embodiments, the invention should not be deemed limited thereto, since other embodiments and modifications will readily occur to one skilled in the art. For example, the description herein has set forth the use of an acoustic horn to couple incident sound to a microphone fixed to the housing of a radiophone device via a rotary acoustic joint. Clearly, acoustic reciprocity dictates that the methods and apparatus taught in the present invention are equally applicable to routing the output sound from interiorly mounted electromagnetic transducers via a rotary acoustic joint to an output acoustic horn. Thus, the transducer and horn together, through the rotary joint, would constitute a sound producing and directing speaker. Also, while the microphone 32 of FIG. 2 is shown as being mounted in close proximity to the throat of the horn 26, this need not be the case. So the microphone may be mounted in any convenient place within the radiophone unit by merely repositioning and/or extending the interconnecting acoustic path; and the size, shape, and locations of the input openings on the top surface of the flip cover may be varied for optimum performance, appearance, and user acceptance. It is therefore to be understood that the appended claims are intended to cover all such modifications as fall within the true spirit and scope of the invention.

-9-

Claims

Claim 1. Apparatus for coupling incident acoustic energy via a pivotable planar acoustic member to a fixed input acoustic channel comprising:

5 (a) an acoustic horn formed as a shaped cavity interior to said pivotable planar acoustic member;

(b) said acoustic horn having mouth and throat sections at distal and proximal ends respectively of said member; and

10 (c) said member having at least one axial pin at said proximal end to serve as an axis of rotation for said member, said pin including an interior channel in acoustic communication with said throat section and said fixed acoustic channel to serve as a rotating acoustic joint to couple acoustic energy therebetween.

Claim 2. The acoustic coupling apparatus of Claim 1 wherein said planar member includes a longitudinal axis extending from said distal to said proximal ends and said at least one pin is a pair of axial pins to produce an
5 axis of rotation for said member transverse to said longitudinal axis.

Claim 3. The acoustic coupling apparatus of Claim 1 wherein said input acoustic channel is fixed to the housing of an electronic device and extends to the input of an electroacoustic transducer for providing electrical
5 signals corresponding to said incident acoustic energy to said electronic device.

Claim 4. The acoustic coupling apparatus of Claim 3 wherein said electronic device is a radiophone and said electroacoustic device is a microphone.

Claim 5. The acoustic coupling apparatus of Claim 4 wherein said radiophone device includes user actuated keys positioned in a key plane and said pivotal planar

-10-

5 acoustic member is pivotable to become adjacent to and parallel with said key plane to cover and protect said keys.

Claim 6. The acoustic coupling apparatus of Claim 5 wherein said planar acoustic member is continuously pivotable for angles less than 180° and said rotating acoustic joint continuously couples said incident
5 acoustic energy for said angles.

Claim 7. The acoustic coupling apparatus of Claim 1 wherein the cross-sectional area of said acoustic horn expands exponentially from throat to mouth along a curved central horn axis.

Claim 8. The acoustic coupling apparatus of Claim 7 wherein said planar acoustic member includes one or more apertures formed into its upper surface for coupling incident acoustic energy into said acoustic horn.

5 Claim 9. The acoustic coupling apparatus of Claim 1 wherein the mouth of said acoustic horn further includes means for modifying horn input directivity.

Claim 10. The acoustic coupling apparatus of Claim 8 wherein said directivity modifying means comprises at least one partitioned element extending into the horn mouth along at least one line generally aligned
5 with said curved central horn axis.

Claim 11. A method of coupling incident acoustic energy via a pivotable acoustic member to an input acoustic channel fixed to the housing of an electronic device, comprising the steps of:

5 (a) routing input acoustic energy from a mouth section of an acoustic horn formed into said pivotable acoustic member to a throat section of said horn, and

-11-

thereafter to a fixed input acoustic channel via a continuously rotatable rotary acoustic joint;

10 (b) forming at least one axial pin into said pivotable member for enabling rotation of said member relative to said electronic device housing; and

(c) forming an acoustic channel through said at least one axial pin to produce a rotary joint for
15 enabling acoustic energy transfer from said throat section to said input channel via said joint.

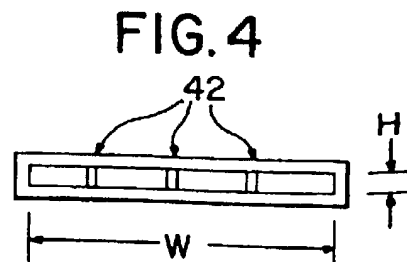
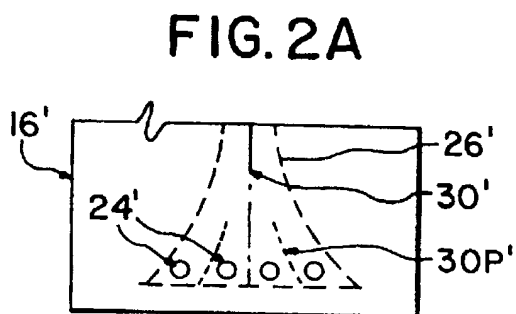
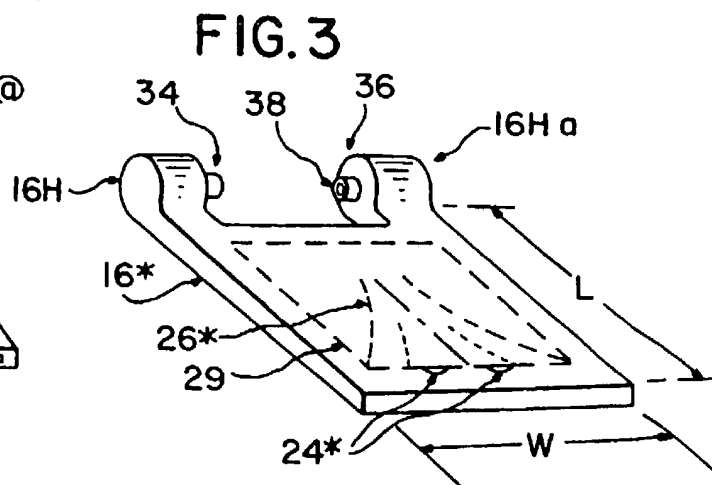
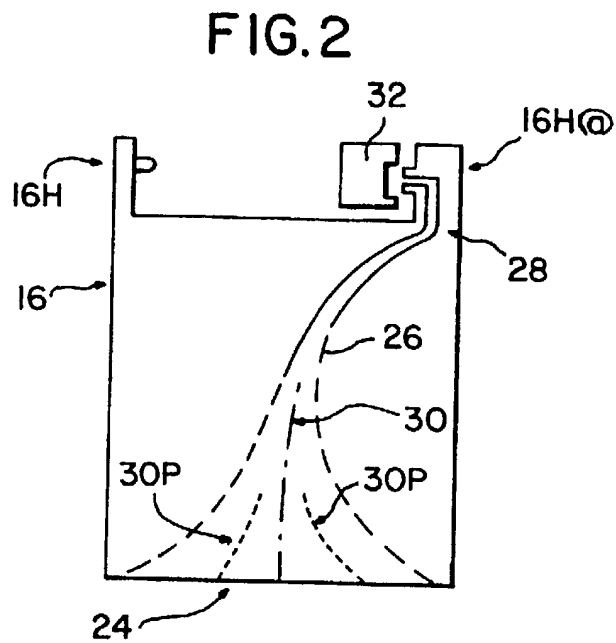
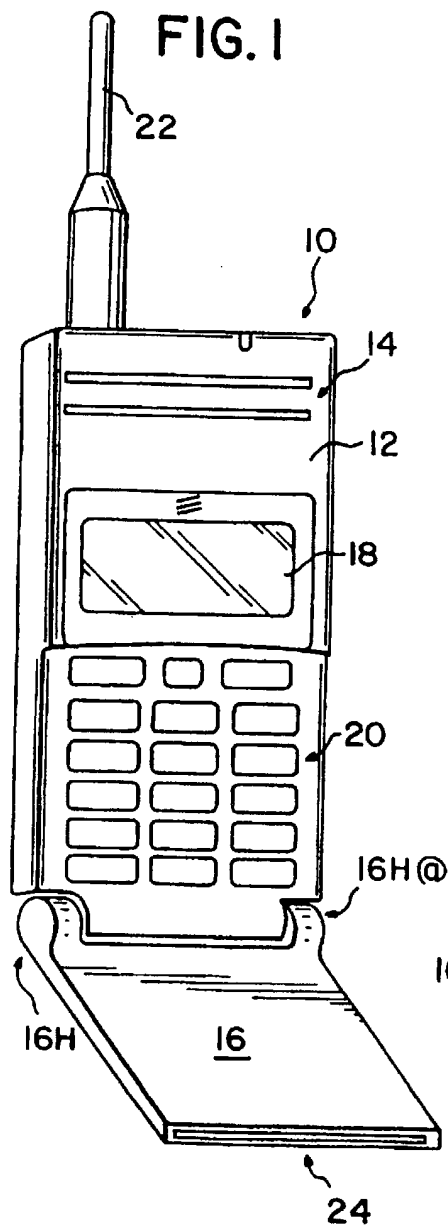
Claim 12. The method of Claim 11 including the further steps of providing said pivotal acoustic member as a planar member and defining a centrally positioned longitudinal axis extending from said mouth section at a
5 distal end of said member to a throat section at a proximal end of said member thereby producing enabled rotation about an axis transverse to said longitudinal axis.

Claim 13. The method of Claim 12 wherein said electronic device is a radiophone and said input acoustic channel terminal terminates at a microphone input, comprising the further steps of coupling said incident
5 acoustic energy to said microphone unit via said rotary joint..

Claim 14. The method of Claim 13 wherein said radiophone includes user-actuated keys positioned in a key plane and said enabled rotation of said pivotable planar member includes the further step of covering an
5 protecting said keys.

Claim 15. The method of Claim 12 wherein said at least one axial pin is a pair of pins, at least one of which includes said rotary acoustic joint, including the further step of limiting said enabled rotation to less
5 than 180°.

1 / 1



INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 97/07487

A. CLASSIFICATION OF SUBJECT MATTER IPC 6 H04M1/02 H04R1/30		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC 6 H04M H04R		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 275 996 A (SIEMENS AG) 27 July 1988 cited in the application see the whole document ---	1-5,11
A	US 4 038 502 A (AMBRUOSO SR ET AL) 26 July 1977 see column 2, line 19 - column 3, line 31; figures 1-5 ---	1-4
A	PATENT ABSTRACTS OF JAPAN vol. 013, no. 046 (E-711), 2 February 1989 & JP 63 240244 A (MATSUSHITA ELECTRIC IND CO LTD) see abstract -----	1-4
<input type="checkbox"/> Further documents are listed in the continuation of box C. <input checked="" type="checkbox"/> Patent family members are listed in annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family		
Date of the actual completion of the international search 16 September 1997		Date of mailing of the international search report 25. 08. 97
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax (+ 31-70) 340-3016		Authorized officer Delangue, P

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 97/07487

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0275996 A	27-07-88	DE 3882721 A	09-09-93
US 4038502 A	26-07-77	NONE	